REMARKS

The Present Enablement Rejection:

In setting forth this rejection, the Examiner concludes that: (1) the deflection of the cantilevers is too small to be visually seen by an operator, and therefore (2) the cantilevers must have some attached power source (e.g.: an electrical or magnetic detector) to sense the bending of the cantilevers.

The Examiner also stated that: ".... it is well documented in the related field that a cantilever is always connected with an external source of power.... to detect the variation of its vibration /or bending....". [Page 3 of the Jan 11, 2005 Office Action].

The Presently Claimed Invention:

The Examiner is correct in concluding that an operator would not be able to easily see the actual physical bending of the individual cantilevers when they deflect. However, this is not how the present invention operates.

Instead, as set forth in each of independent claims 1, 14, 30, 32, 33, and 36, what the operator sees is a visual effect or pattern change caused by movement of a **diffraction grating**, as follows.

As seen in Figs. 3 and 6, cantilever fingers 30 and frame fingers 41 together form diffraction grating 42. [See Paras. 0028 and 0031 of the specification].

In accordance with the invention: "... the movement of the cantilever 28 causes the cantilever fingers 30 to move with respect to stationary frame fingers 41, thereby producing an optically visible event." [See Para. 0038 of the specification].

The deflection of cantilever 28 with respect to stationary frame fingers 41 changes the dimensions of the spacings between the individual cantilever fingers 30 and their adjacent frame fingers 41. This produces an easy to see visual effect, as explained below.

What is a "diffraction grating" and how does it operate?

According to Random House Websters College Dictionary, © 1997: "diffraction" is: "a modulation of waves in response to an obstacle, as an object, slit or grating, in the path of propagation, giving rise in light waves to a banded pattern or a spectrum."

Also according to Random House Websters College Dictionary, © 1997: a "diffraction grating" is: "a reflective surface etched with fine lines that is used to produce optical spectra by diffraction".

An explanation of the operation of a standard diffraction grating is found in Appendix A entitled "Theory of Diffraction Grating" downloaded from the internet at: http://physics.nad.ru/Physics/English/DG10/theory.htm.

The Examiner is invited to view the contents of Appendix A on the internet, and to direct his attention to the three animations at the bottom of this webpage.

As seen in this example, diffraction grating operates as follows. When a beam of light passes through a pair (or a series) of very closely spaced parallel slits, an interference pattern is generated such that a striped or banded pattern of light can be projected on a screen.

This banded pattern occurs due to the fact that the slits are spaced close enough together such that their spacing causes adjacent light waves to interfere in phase (thereby producing brightened bands) and to interfere out of phase (thereby producing darkened bands).

This banded pattern is clearly seen in each of the three animations at the bottom of the webpage of Appendix A.

As can be clearly seen viewing the three animations at the bottom of the webpage of Appendix A, very small variations in the width of the slits or the distances between the slits produce dramatic visual effects. For example, in the second animation, the distance between

the widths of the slits is only varied by 1000 to 10,000 nm. In the third animation, the width of one slit is varied in the range of 500 to 1,500 nm, again producing dramatic visual effects that can easily be seen by the naked eye.

As can therefore be appreciated, a diffraction grating provides easy to see dramatic visual effects caused only by very small movements of one part of the grating with respect to another part of the grating.

This is exactly how the present invention operates. Specifically, very small movement of cantilever fingers 30 (caused by deflection of cantilever 28) with respect to stationary frame fingers 41, changes the spacing between adjacent fingers 30 and 41, producing a correspondingly easy to observe visual effect. As a result, a very small cantilever deflection can be easily seen by the operator.

As a result, there is no need to connect the cantilevers of the present invention to an electronic or magnetic detector to measure cantilever deflection.

Such an easy to see visual effect is also seen in Applicants' Fig. 9 where brightened bands are formed at the 0^{th} and 1^{st} orders of diffraction. As stated in Para 0051 of the specification: "The energy distribution between the diffraction orders depends upon the relative distance between the moveable and fixed inter-digital fingers." Thus, movement of cantilever fingers 30 with respect to stationary frame fingers 41 changes the location of the brightened bands formed at the 0^{th} and 1^{st} orders of diffraction (i.e.: operating the same way as shown in the animations at the bottom of Appendix A).

The Examiner is correct in stating that the all of the other references (i.e.: Atalar, Lee, Thundat and Bashir) are connected to an externally powered detector to product or sense cantilever movement.

This fact is one of the important advantages of the present invention. Specifically, an externally powered detector is ***not*** required to sense movement of the present cantilevers,

because such deflection may instead be easily seen by the movement the cantilevers causing changes in patterns of light produced by the diffraction grating.

In view of the forgoing, the Applicants respectfully request reconsideration and withdrawal of the present enablement rejections to the claims.

Conclusion:

For the reasons presented above, all claims are believed to be in condition for allowance. A Notice of Allowance is therefore respectfully requested.

Should the Examiner feel that a telephone conference would advance prosecution of the present application, he is invited to call the undersigned attorney at the number listed below.

Respectfully submitted,

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Date: April 14, 2005

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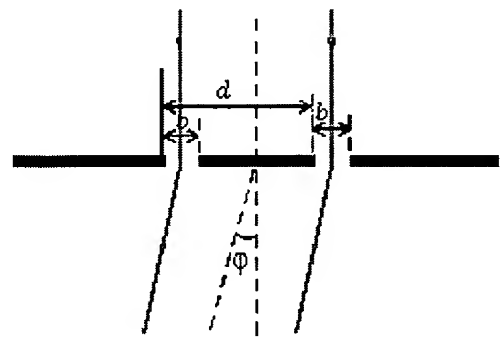
THEORY OF DIFFRACTION GRATING

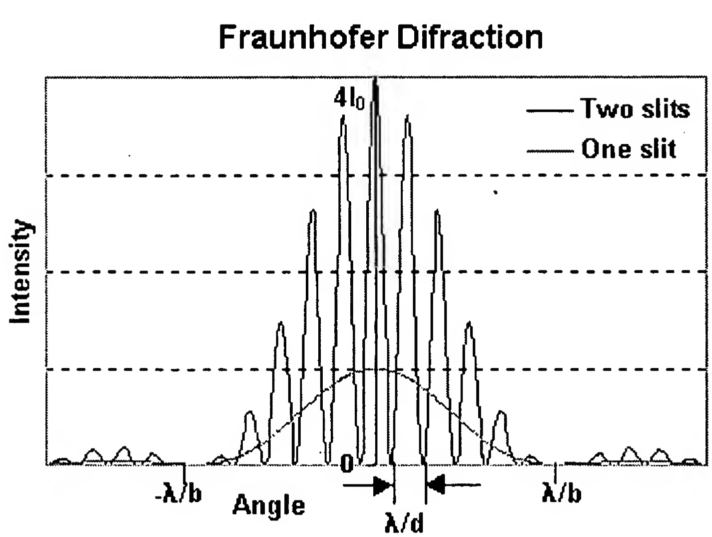
Diffraction Grating is optical device used to learn the different wavelengths or colors contained in a beam of light. The device usually consists of thousands of narrow, closely spaced parallel slits (or grooves). Because of interference the intensity of the light getting pass through the slits depends upon the direction of the light propagation. There are selected directions at which the light waves from the different slits interfere in phase and in these directions the maximums of the light intensity are observed. These selected directions depend upon wavelength, and so the light beams with different wavelength will propagate in different directions. The condition for maximum intensity is the same as that for the double slit or multiple slits, but with a large number of slits the intensity maximum is very sharp and narrow, providing the high resolution for spectroscopic applications. The peak intensities are also higher and depend proportionally to the second power of amount of the slits illuminated.

In the beginning let us consider the diffraction from double slit, which consists of two parallel slits illuminated by a flat monochromatic wave. Calculations show that the intensity of the light getting pass through the slits will depend upon the angle φ between the direction of the light propagation and the perpendicular to screen:



$$I = 2I_0\left[\frac{\sin(kb\varphi/2)}{kb\varphi/2}\right]^2\left[1+\cos(k\Delta+kd\varphi)\right]$$

where I_0 is the intensity of the light in the center of diffraction pattern when only one slit is opened, b is the width of the slit, d is the distance between the slits, $k=2\pi/\lambda$ is the wave factor, λ is the wavelength, Δ is the difference of the optical lengths of the interfering rays (in the case, for example, when the wave is incident not perpendicularly to the screen or one slit is covered by glass). The first multiplier of the equation in the square brackets describes the Fraunhofer diffraction on one slit and the second multiplier describes the interference from two point sources. The total energy of the light getting through the slit is proportional to b, while the width of the diffraction pattern is proportional to $1/b$. For this reason the intensity of the light I_0 in the center of diffraction pattern will be proportional to b^2. In the limits of the first diffraction maximum we can see N interference fringes, where $N=2d/b$.



This figure shows the dependence of the light intensity on the angle in the case of diffraction on one slit (red curve) and for two slits diffraction (blue curve). We can see in this figure that the maximal intensities of the interference fringes follow the curve for diffraction on one slit.

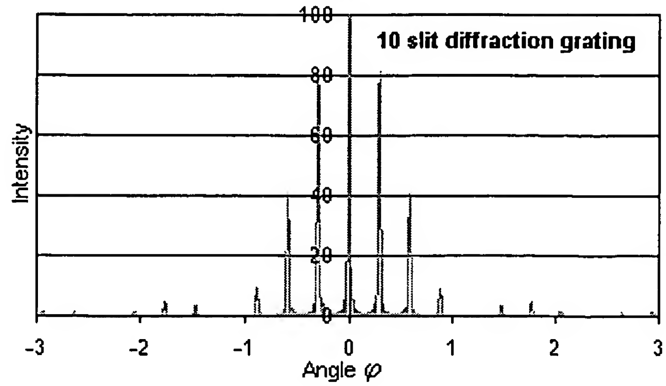
Talking about "Fraunhofer" diffraction we mean the far-field diffraction, i.e. when the point of observation is far enough from the screen with the slits. Quantitatively the criteria of the Fraunhofer diffraction is described by the formula:

$$z \gg d^2/\lambda$$

where z is the distance from the screen with the slits

to the point of observation. In the close proximity to the screen with the slits the diffraction pattern will be described by the Fresnel's equations

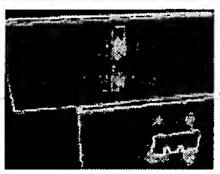
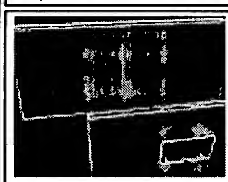
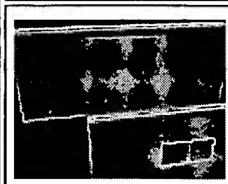
Next, we shall consider the diffraction grating, which consists of N parallel slits. In this case the light waves from every slit will interfere each other producing the interference fringes as shown in figure. Because of diffraction the distribution of the light intensity behind of every slit will not be isotropic (see figure for diffraction at one slit). For diffraction gratings both these effects take place, so the resultant intensity of the light on the screen is described by the equation:



$$I_\varphi = I_0 \left(\frac{\sin(kb\varphi/2)}{kb\varphi/2} \right)^2 \left(\frac{\sin(Nkd\varphi/2)}{\sin(kd\varphi/2)} \right)^2$$

The first multiplier of the equation describes the Fraunhofer diffraction on one slit and the second multiplier describes the interference from *N* point sources.

It is seen from the figure that $d \cdot \sin\varphi$ is the path length difference Δ between the rays emitted by the slits. If it is equal to the integer number, then the oscillations will interfere in phase magnifying each other. Therefore, we can write the equation for the main maximums of interference pattern: $d \cdot \sin\varphi = m\lambda$, where $m = 0, 1, 2, \ldots$

	This animation shows the experiment when the width *b* of the silts is varied, while the distance *d* between them is constant. We can see in the figure that for the narrower slits the diffraction pattern is wider and the visibility is lower. The frequency of the interferometric fringes is the same.
	This animation shows the experiment when the width *b* of the silts is constant (1000 nm) and the distance *d* between them is varied in the range 1000-10000 nm. Wavelength is 600 nm. The frequency of the interferometric fringes is increasing proportionally to the distance *d* between the slits, while the width of the diffraction pattern is the same and depends only on *b*.
	This animation shows the Fraunhofer Diffraction on one slit. The width *b* of the silts is varied in the range 500-1500 nm, wavelength equal to 600 nm.

Additional information on diffraction you can find at website HyperPhysics